

Thinking ahead: designing future-ready Gas installations and transport networks with distributed monitoring

It is not often that an entirely new form of sensor is rapidly applied across hundreds of thousands of kilometers of assets. It is truly extraordinary the speed at which Distributed Fiber Optic Sensing (DFOS) has been adopted by various industries to monitor a wide range of linear assets including pipelines, power cables, rail tracks, telecommunication cables, and country borders.

This evolution is even more remarkable considering the expansion of applications driven by new sensing capabilities and software innovation. The ability to transform standard telecommunication cables into highly sensitive sensing cables is a major factor driving the widespread use of DFOS across industries.

Multiple sensing capabilities

DFOS technology incorporates significant scientific developments in the field of advanced photonics. Various lasers, sensors, and software platforms are used to monitor and pinpoint minute environmental effects on the fibers, such as temperature fluctuations, acoustic signals, and physical strain.

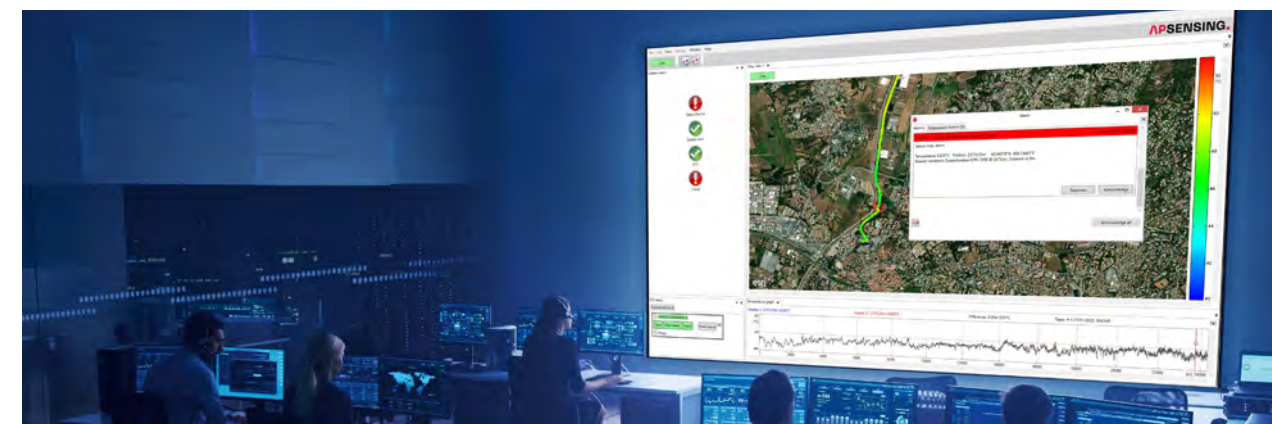
Benefits to the Gas industry

DFOS is already used extensively within the Gas industry to monitor transmission pipelines transporting natural gas and CO₂. The benefits of Distributed Acoustic Sensing (DAS) include mitigating the risks posed by Third-Party Interference (TPI), reducing total emissions during a leak event,

and cutting response times by confirming and localising leaks to within a few meters. The challenges of monitoring remote events along long pipelines are a perfect fit for DAS capabilities, adding significant value to existing fiber optic network investments. European Transmission System Operators (TSOs) for power and Gas have conducted substantial validation testing programs, followed by long-term monitoring periods to evaluate and minimise false alarm rates.

The detection of real TPI threats is a common occurrence across industries – it is no longer a surprise when large excavators are detected near natural gas transmission pipelines. In fact, asset operators using DAS for TPI monitoring frequently report that threats are more common and severe than previously expected.

Artificial intelligence (AI) has proven instrumental in classifying these acoustic signals, distinguishing genuine threats from loud but normal background activities near cross-country and urban pipelines. AP Sensing, in cooperation with pipeline and asset operators, has performed hundreds of TPI tests under field conditions and currently monitors thousands of kilometers of assets. AP Sensing's global monitoring deployments and field trials provide the foundation for AI tools to achieve the performance and reliability required for effective field deployment. Events signatures are added in a constant process of improvement, for example acoustic signatures of lightning strikes are being incorporated into the AI model because lightning is a common cause of leaks



in transmission Gas pipelines.

Ground movement is another major threat to transmission pipelines. Fortunately, Distributed Strain Sensing (DSS) allows for the monitoring of ground movement in known trouble spots using specialised fiber optic cables optimised for this exact purpose.

The presence of DAS in the midstream sector includes applications for raw natural gas pipelines and multiphase flowlines at production sites. In these scenarios, significant benefits are achieved by improving the leak detection performance of single-phase sour natural gas pipelines and providing effective monitoring methods for multiphase gathering lines.

Furthermore, Gas distribution networks are increasingly being monitored with DAS for leaks and TPI. While the urban environment and low operational pressures make leak detection challenging, strategies adapted from the water utility market are now being used to improve performance and reliability.

Advancements in the LNG sector

In the LNG sector, the ability of DFOS to measure temperature continuously along a cable has resulted in rapid adoption and significant benefits for operators. Distributed Temperature Sensing (DTS) provides technical solutions and cost efficiencies for various monitoring challenges unique to LNG facilities.

By monitoring the temperature of thermally insulated pipes and tanks, DTS can detect leaks, spills, and insulation failures. The specific challenges of LNG leak detection explain the near-universal adoption of DTS in new LNG terminal projects. Today, more than 20 LNG terminals are monitored by AP Sensing's DTS systems.

Beyond containment monitoring, DTS is utilised to track the health of electrical equipment within

LNG terminals. The integrity of an LNG tank's concrete base is regulated by heating elements that maintain temperatures within strict parameters; DTS cables embedded in the concrete monitor these temperatures to ensure the required ranges are met. In modern electric-driven LNG trains, DTS is deployed to monitor the temperature of numerous on-site transformers. Overall, the risks mitigated by DTS in LNG terminal installations are substantial. More recently, DTS applications in this sector have expanded to include the temperature monitoring of loading arms and the pipe walls under insulation.

The software ecosystem

The effective use of DFOS relies heavily on a robust software ecosystem tailored to specific industry requirements. For the Gas industry, specialised software for leak detection, temperature monitoring, TPI, and strain monitoring was developed in close cooperation with operators under field conditions. Results can be visualised across multiple platforms, enabling stakeholders to perform their tasks effectively. Whether integrated directly into SCADA/DCS systems or accessed via mobile applications, the operational and security requirements of pipelines can be met in real time.

Synergies with other monitoring platforms

DFOS is frequently used in conjunction with SCADA/DCS, Real-Time Transient Models (RTTM), and satellite surveillance. Integration is typically managed directly at the SCADA/DCS level. Furthermore, real-time transient models can leverage the ground temperature values measured by DTS along the pipeline to improve inventory calculations and optimise overall transport capacity. ●